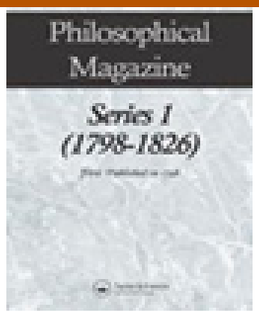


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# II. Historical remarks relative to the manufactures of iron and steel in Great Britain

Mr. David Mushet

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## II. *Hiſtorical Remarks relative to the Manufactures of Iron and Steel in Great Britain. By Mr.* DAVID MUSHET, *of the Clyde Iron Works. Communicated by the Author.*

IT is uncertain at what period the manufacture of iron commenced in Britain. It is probable that the working of the iron mines of Cornwall by the Phœnicians, would introduce into the country a claſs of men ſkilled in all the then known metallic ores; capable of appreciating their true value, by converting the riches of an unexplored country, either to their own immediate wants, or to the conveniencies of the unſkilful inhabitants. The invaſion of England by the Danes, and their conſequent eſtabliſhment, would, moſt likely, add to the former ſtock of knowledge in the art of mining and fuſing ores. Large heaps of ſcoria are to this day met with in many places in England, with ſo great an accumulation of ſoil as to grow trees of a large ſize *; theſe heaps are called Danes cinders, and are in our times ſmelted to advantage for the production of crude iron. From whatever period the iron trade may date its origin; certain it is, that towards the end of the 16th and early in the 17th centuries we find it had attained a pitch of magnitude almoſt incredible, at a time ſo hoſtile to the peaceable views and induſtry of the manufacturer. Hence we find that cannon and mortars, of various calibres and conſtructions, were fabricated from caſt-iron at ſome of the Engliſh works; and that this ſpecies of manufacture was in conſiderable requeſt on the continent. The calibre of the gun was in thoſe days, and within theſe forty years, formed by a loam core of the exact diameter placed vertically in the middle of the mould. The boring and turning mills were quite unknown, together with all that ſcrupulous exactitude which

* Dudley mentions that as early as 1620, oaks were found of a large ſize decayed on the tops of large hills of cinder.

diſtinguiſhes

diſtinguiſhes the artilleriſt, and the manufacture of the preſent times.

Hitherto caſt and malleable iron were obtained from ores with the charcoal of wood, and the manufacture of theſe articles had acquired certainty and extent.

If credit could be given to the *metallum marks* of Dudley, in the 12th year of James, anno 1615, there were at that period not leſs than 300 blaſt furnaces for ſmelting iron ore with charcoal; each of which had fuel, upon an average, for 40 weeks per annum. The average produce in crude iron at each furnace, 13 tons per week, makes the total annual quantity 180,000 tons*; for the production of this aſtoniſhing quantity, calculating at the rate of two loads of charcoal for each ton of iron, and reckoning 8 cwt. charcoal to each load, we find the amazing quantity of 144,000 tons of charcoal neceſſary. As wood in charring nearly affords bulk for bulk, and as a cubic foot will be found to weigh on an average nearly 18·75 pounds avoirdupoiſe, we find that 17,310,000 cubical feet of timber was neceſſary to produce this quantity of charcoal. Again, let this quantity of charcoal be valued at the preſent price (in Scotland), viz. 4*l.* per ton, its value will amount to 576,000 *l.* a ſum little ſhort of the annual value of all the pig iron manufactured at this time in England, Scotland and Wales.

Mr. Dudley alſo informs us, that at the ſame period there were reckoned 500 forges and iron mills for refining the crude iron, and making it into malleable bars. Theſe on an average made 3 tons each per week, for 50 weeks annually = 150 × 500, annual produce in bar iron 75,000 tons; a produce little ſhort of the whole annual export of the Ruſſian and Swediſh markets. Three loads of charcoal were requiſite to refine metal for 1 ton of bar iron; ſo that, if the above calculation of 8 cwt. to each load is adopted, a further

* Upwards of 80,000 tons more than is at preſent manufactured in Britain with pit-coal.

quantity

quantity of 90,000 tons of charcoal would be requiſite for a year's ſupply at that period = 10,732,000 cubical feet *.

Let the waſte of the refining furnace in thoſe days be reckoned equal to 50 per cent. 112,500 tons of pig iron muſt have then been uſed to fabricate 75,000 tons of bars, and a reverſion of 67,500 tons caſt into cannon, mortars, wares, &c. or exported in a raw ſtate as pig iron or ſhip ballaſt.

However much the above quantities may be exaggerated, as I am inclined to think they are, yet they ſeem to prove that, at the commencement of the laſt century, the iron buſineſs had obtained an eminent rank among the manufactures of the country. The progreſs of agriculture and the increaſe of population under the reign of the peaceable James had at length taught the huſbandman and the proprietor the value of cultivated fields. The great conſumption of wood for the navy and iron works had greatly exhauſted the principal foreſts of ſupply: tracts of country became cleared, and in proportion as the ſpirit of cultivation increaſed, the annual quantity of fuel for the manufacturing of iron diminiſhed.

Pit-coal had been long known before this period, and wrought at Newcaſtle prior to the year 1272. Annually vaſt quantities of it were exported to Holland, and the Low

† The aggregate quantity of timber neceſſary for the manufacture of iron alone amounts to 28,062,000 cubical feet. Let an acre of ground be ſuppoſed to afford 2000 cubical feet of timber, then it will be found that 14,031 acres of land were annually ſwept to ſupply the iron manufacturers. Admitting that wood fully replaces its cubical contents in 18 years, then 252,558 acres of land would have been required to furniſh the neceſſary conſumption of timber, without in the end diminiſhing the ſupply. Beſides iron works, ſmiths' and nailors' fires, manufactories of every ſort were carried on by means of wood; even at a time when pit coal was exporting to other countries. The data on which I have made this calculation are moderate. I have ſuppoſed the cube of charcoal produced from the ſame cube of timber; which is not ſtrictly the caſe, as ſome woods ſhrink conſiderably. I have likewiſe reckoned an acre to produce 2000 cubical feet, which I ſuppoſe wood in a natural ſtate ſeldom does, taking it upon an average of the whole country.

Countries,

Countries, for the uſe of the ſmithy, and other manufacturers requiring an intenſe and continued heat. Yet in England prejudices ran ſo ſtrong againſt its application to the manufacturing of caſt or malleable iron, that the projectors of this uſeful undertaking met with every obſtacle which the narrow, unenlightened minds of the eſtabliſhed manufacturers could deviſe.

James granted ſeveral patents for the excluſive right of manufacturing iron with pit-coal. None of the projectors, however, were ſucceſsful, till 1619, when Dudley ſucceeded in making coak pig iron, though only at the ſparing rate of 3 tons per week. By this time many of the iron works were at a ſtand for want of wood; the conſequence was, an advance on the price of iron: this therefore rendered it a lucrative buſineſs to thoſe manufacturers whoſe ſupply of wood was ſtill undiminiſhed, and, of courſe, made them hoſtile to any innovation whereby the preſent price of iron was likely to meet with a reduction.

This period of prejudice ſo unfavourable to innovation in the iron buſineſs, was followed by one more general, and more calamitous for the nation. Amidſt the diſtraction occaſioned by civil war, neither innovation nor improvement could be expected. Patents however were granted to ſome during the commonwealth for the excluſive manufacture of iron in the new way; in one of which it was believed Cromwell was a partner: theſe partly ſhared the ſame fate as did their predeceſſors, and none ſucceeded in eſtabliſhing a manufactory either of extent or of certainty. In 1663 we find Dudley applying for his laſt patent, and ſetting forth, that at one time he was capable of producing 7 tons coak pig iron weekly, with an improved furnace 27 feet ſquare, and bellows which *one man could work for an hour without being much tired.*

It was not till impelled by neceſſity, by the rapid decline of the annual growth of timber, that pit-coal became an object of univerſal eſtimation. When the improvements on machinery

machinery had attained a pitch of certainty, and experience had taught the mechanic the manifold advantages to be derived from the ſteam-engine, men of induſtry and enterpriſe began to think of extending the manufactures of the country in iron with pit-coal. Small furnaces ſupplied with air from leathern bellows, blown by oxen, horſe, or human labour, became exploded, and an increaſe of ſize took place, together with an increaſe of the column of blaſt neceſſary to excite combuſtion. But as it ſeldom happened, that to the advantage of having pit-coal, ores, and limeſtone concentrated in one ſpot, water alſo was added, it became neceſſary to form a ſubſtitute. For this purpoſe, the ſteam-engine, that ſuperhuman invention, was applied. Rude and unpoliſhed no doubt were its early deſigns and execution—rapid however have been its improvements; and at the preſent time, by many it is believed to have arrived at the higheſt poſſible pitch of human perfection.

With the improvements in machinery the advancement in the practice of manufacturing coak pig iron kept pace; and it is now a certain truth, that with pit-coal in our time we produce a quality of pig iron ſuperior for every purpoſe of the arts (bar iron making excepted) to that at any time made with charcoal of wood, and in the following increaſed proportion:

| | Tons. |
|---|---|
| Average annual produce of a charcoal furnace 180 years ago | 600 |
| Some furnaces in England on an average now produce 40 tons per week | 2080 |
| Value of the former when manufactured £.6 per ton | £.3600 |
| Value of the latter on an average of the qualities 6*l.* 10*s.* | £.13520 |

By comparing the value of pig and bar iron at preſent with what it ſold for 180 years ago, an accurate notion may be formed of the increaſed price of labour and materials attached to iron works.

About

| | £. | s. |
|---|---|---|
| About the year 1620 charcoal pig iron ſold for per ton | 6 | 0 |
| In the year 1792, carbonated pig iron - | 8 | 10 |
| In the year 1798 ditto, ditto - - | 10 | 0 |
| Coak pig iron when invented ſold at - - | 4 | 0 |
| In the year 1792 melting pig iron ſold for - | 5 | 10 |
| In the year 1798 ditto - - - | 7 | 10 |
| Malleable iron made with charcoal ſold for - - | 15 | 0 |
| The ſame in 1792, to be drawn into wire, for - | 23 | 0 |
| Ditto in 1798 - - - £.27 or | 28 | 0 |
| The firſt bar iron made (1620) with pit-coal ſold for | 12 | 0 |
| The ſame iron in 1792 ſold for - - | 18 | 0 |
| Ditto in 1798 for - - - | 22 | 0 |

By theſe ſtatements it may be ſeen that all along there has been preſerved an analogy between the value of the reſpective ſtates of the metal. We cannot, however, be but aſtoniſhed at the mighty advance on iron within the laſt ſix years, nearly and in ſome caſes more than equal to the advance of a period of 170 years before.

Let it be taken for granted, that the manufacture of England, Scotland and Ireland at the beginning of the 17th century amounted in crude iron to 180,000 tons.

| | |
|---|---|
| 112500 tons of which, ſuppoſe, produced 75000 tons bars at 15*l.* Amount - | £.1,125,000 |
| 67500 tons caſt into guns, mortars, ſhips' ballaſt, &c. &c. at 10*l.* - - | 675,000 |
| 180000 tons, amount of the manufactures of iron at that early period - - | £.1,800,000 |

In Britain at preſent the total produce in pig iron does not exceed 100,000 tons; and reckoning on an average that 33 cwt. of crude iron produces 1 ton of bars, and that the manufacture of malleable iron amounts to 35,000 tons per annum,

57750 tons of crude iron will then be neceſſary to form 35000 tons of bars at 20*l.* £.700,000

42250 tons caſt into cannon, cylinders, machinery wares, &c. at 14*l.* - - 591,500

100000 tons amount of the native manufacture of iron at this period - - £.1,291,500

The extenſive manufacturers of this country have for many years paſt demanded an additional ſupply of foreign bar iron. This has been chiefly received from Ruſſia and Sweden, and the annual quantity may be averaged for the laſt 20 years at 70000 tons, at 18*l.* per ton, - £.1,260,000

£.2,551,500

This may be taken as the annual amount of one raw material, the chief part of which becomes more valuable in an uncommon ratio, by ſubſequent labour.

Amount of the native manufacture at the beginning of laſt century, when the raw material was exported in quantity - - 1,800,000

Balance in favour of this period - - £.751,500

excluſive of the additional value ſtamped upon iron in the now extenſive operations of ſlitting it into rod iron for nails, rolling it into hoops, and converting it into ſteel. In theſe manipulations value is gained as follows: Rod iron 3*l.* 10*s.* per ton. Hoops 7*l.* Bliſtered ſteel 7*l.* to 9*l.* Tilted ſteel 10*l.* to 12*l.* and German ſteel 25*l.* to 28*l.* per ton. Caſt-ſteel according to the ſize of the bars 30*l.* to 45*l.* per ton. Some of theſe operations are attended with a waſte of metal, though not nearly in the proportion of making bar iron from pig iron. The manufacturer of ſteel alſo buys his iron at the

the rate of 20 cwt. to a ton; but in felling fteel he gives at the rate of 21 cwt. 1 qr. 20 lb. to each ton, or 120 lb. inftead of 112 lb. for each hundred weight.

It is uncertain whether the quality of fteel, fabricated from Engliſh iron at the above early period, was in any way comparable with what we now make from foreign iron; or whether the artiſts were ſupplied with this ſtate of the metal from Spain and the Low Countries. The latter is moſt probable.

In whatever point of view the iron trade may be conſidered with regard to this country, the advantages derived from its progreſs have been great: whether we conſider it as having cleared the country of vaſt tracts of wood—affording at the ſame time an ample indemnification for the labour beſtowed—the conſequent improvement of climate, and the ſpread of agriculture; as having placed us at the head of the manufacturing countries of Europe; as affording us at all times a plentiful ſupply for the conſtruction of every ſpecies of machinery; as being an arſenal for the rearing and protecting an extenſive navy; or, as having been a ſource of wealth to many individuals, and at the ſame time affording a competent recompenſe for the labour of a number of our fellow creatures.

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III. *Account of Count* RUMFORD's *Experiments on the conducting Power of Liquids with Regard to Heat, and a Deſcription of the Apparatus employed in the Experiments. Extracted from his* Eſſays, Political, Economical and Philoſophical, *Vol. II.*

OUR limits will not allow us to make long extracts from the intereſting experiments of this ingenious philoſopher, who has done more in what regards the ſcience of heat than all who have ever written upon it beſides. We only hope to be able to convey ſome intelligible ideas on the ſubject to